STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

POPULATION STUDIES OF GAME FISH AND EVALUATION OF MANAGED LAKES IN THE UPPER COOK INLET DRAINAGES

by

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RESEARCH PROJECT SEGMENT

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Project No.:	F-9-10		
Study No.:	G-III	Study Title:	LAKE AND STREAM INVESTIGATIONS
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Period Covered: July 1, 1977 to June 30, 1978.

ABSTRACT

Native Alaska rainbow trout, Salmo gairdneri Richardson, strains from Swanson River and Talarik Creek demonstrated better first year survival than the Ennis, Montana strain; however, native trout growth was poorer. Of the two Alaska strains the Swanson fish exhibited better survival but slower growth.

Fingerling rainbow plants in Canoe and Long lakes suggest Swanson fish may have a tolerance to low dissolved oxygen and to stickleback, Gasterosteus aculeatus Linneaus, competition.

Landlocked coho, Oncorhynchus kisutch (Walbaum), of wild parentage have significantly better first year survival than domestic trout.

The cost of producing a catchable trout in stickleback infested waters is significantly greater than in a non-stickleback environment. Cost to the creel in lakes stocked with coho is significantly less than those lakes stocked with domestic trout, due to their greater survival.

BACKGROUND

The Alaska Department of Fish and Game fish stocking program contributes substantially to the statewide recreational fishery. Department biologists recognize that game fish stocking does not always produce desired results in the lentic environments of Alaska. Subsequently a study was designed to identify and analyze the effects various physical and biological parameters have on fish. Accordingly, detailed limnological and physical data have been collected for lakes in the Matanuska-Susitna Valleys.

During the early phases of this project plankton abundance was evaluated as a potential limnological method for indicating nutritive condition. Primary objectives of plankton sampling in the Matanuska-Susitna Valley

lakes were to: (1) establish the relative plankton abundance in each study lake, (2) identify zooplankton species present during ice free conditions, and (3) eventually develop an index relative to the biological productivity of each lake. The scope of the project was later broadened, however, to include periphyton and chlorophyll a analysis.

Macro and micro invertebrates were collected in 1974, 1975, and 1976 from three study lakes following chemical treatment of two of the lakes to eradicate undesirable fish species. The untreated lake was used as a control lake. Post-chemical treatment studies continued for three years, with analysis of limnological, chemical, and invertebrate information regarding: (1) effects of treatment on invertebrate organisms, (2) time required for a lake to detoxify, (3) time required for pretreatment invertebrate organisms to reestablish, and (4) determination of fish biomass prior to and following chemical treatment under similar stocking densities.

Results of the limnological phase of study have definite fishery management application. The investigated indicators of biological productivity, i.e., plankton abundance, periphyton, chlorophyll a, water chemistry, and the morphoedaphic index, strongly indicate a relative ranking of lake productivity. After combining the various indicies in a numerical comparison of biological, chemical and physical properties, and morphoedaphic index (specific conductance ÷ mean depth) statistical analysis revealed that any of the investigated parameters could be used to derive a ranking of relative productivity. Due, however, to the ease of determining the morphoedaphic index and its close correlation to other indicies, the morphoedaphic index is used for most purposes in establishing a ranking of lake productivity.

Other results derived from the limnological studies and pertinent to the management of sport fish waters have been an assessment of rehabilitation and identification of both macro and micro invertebrates. Comparison of zooplankton trends in Matanuska-Susitna Valley lakes chemically treated to eliminate undesirable fish populations with trends in a nontreated lake having a stable zooplankton community indicates that treated lakes require between one and two years to reestablish zooplankton production and three years to attain a production level of previous dominance and abundance.

Although lake stocking studies were initiated in 1974, it wasn't until 1977 that limnological studies were de-emphasized. Conversely an increase in stocking studies has followed to provide information for the development of improved stocking procedures in lakes of varying limnological characteristics. During this study phase, increased emphasis has been placed on: (1) evaluation of trout survival in stickleback and non-stickleback environments; (2) survival, growth and total production of stocked game fish at different stocking densities in lakes of varying limnological characteristics; (3) survival, growth, and total production of domestic and wild trout strains in varied lentic environments; and (4) a survival and growth comparison of fry and fingerling plants. Thus far lake stocking studies have provided information to enable: (1) survival and growth comparisons

of fry and fingerling plants; (2) evaluation of survival and growth for Winthrop, Washington; Ennis, Montana; Talarik Creek, Alaska; and Swanson River, Alaska rainbow trout; (3) evaluation of coho survival versus rainbow survival in a stocked lake; and (4) evaluations of the British Columbia stocking curve for converting numbers of larger fish to equivalent numbers of smaller fish.

With limnological and physical data collected from Matanuska-Susitna Valley lakes, stocking densities are being adjusted to offset the negative effects these parameters may have. In addition, continued research, i.e., survival, growth, tolerance to competitors, is being conducted on the same species but different strains and on one species versus another, both in similar lentic environments.

To characterize what type of waters stocked fish are in, whether they are considered fertile, average or infertile, a table of the morphoedaphic index (MEI, or conductance divided by mean depth) can give a gross measure of potential productivity (Table 1). A breakdown into levels of productivity is relative; however, for categorizing and management purposes; MEI values above 13 are most productive, values below three are least productive, while values between 3 and 13 range from moderately low to moderately high in productivity. The numerical points separating the productivity levels are arbitrary and serve only to aid in a general understanding of productivity levels within the various study lakes.

Many of the various lentic environments of the Matanuska-Susitna Valleys have been stocked with hatchery reared fish. Prior to 1975 rainbow trout eggs from fall spawning Ennis, Montana fish and spring spawning Winthrop, Washington fish supported the State's trout cultural program. Fall spawners provided trout for early summer plants with potential catchables by the subsequent fall. The spring spawners provided trout for stocking the following fall, with fish entering the sport fishery in the spring. Both strains have extensive domestic histories as they are far removed from wild parentage. This feature many cause them to be vulnerable to the environmental conditions of Alaska.

Because of the low survivals, high cost to the creel and the risk of possible importation of disease organisms, Alaskan brood stocks are currently being developed and evaluated. Wild fish egg sources for these stocks are from Swanson River on the Kenai Peninsula and Talarik Creek in the Bristol Bay area. Bristol Bay trout were chosen primarily for their large size and long life span, the majority of which reach sexual maturity in seven to eight years. Kenai fish were chosen because of a lake rearing background, which includes stickleback competition. Kenai Peninsula trout mature in four to five years.

RECOMMENDATIONS

1. Survival, growth and total yield of Ennis stran trout in Johnson Lake should be determined.

Table 1. Morphoedaphic Index Values for Selected Lakes in the Matanuska-Susitna Valleys (Watsjold, 1976).

Lake	MEI	Lake	MEI
Lucille	23.5	Memory	5.3
Harriet	21.3	Reed	4.9
Canoe	18.1	Meirs	3.4
Falk	16.7	Rocky	3.1
Echo	15.9	Christiansen	1.8
Seymour	14.6	Benka	1.3
Finger	13.3	Loon	1.3
Junction	13.2	South Rolly	1.2
Kepler	11.6	Big No Luck	1.1
Irene	10.4	Twelve Mile	1.0
Long	9.4	Prator	0.9
Victor	9.3	Milo #1	0.7
Knik	9.1	Chicken	0.5
Matanuska	8.2	Byers	0.5
Florence	7.6	Marion	0.4
Johnson	7.4		

2. Techniques and equipment necessary to determine survival, growth, and yield of Ennis, Swanson, Talarik rainbow trout strains and landlocked coho in stocked study lakes should be developed.

3. Domestic brood trout and Alaskan trout should be evaluated under varied lentic conditions.

4. Brood trout candidates should be evaluated with landlocked coho when applicable.

5. When survival estimates are available cost to the creel should be continued for fish stocked in study lakes.

OBJECTIVES

1. To determine survival, growth, and total yield of stocked game fishes in landlocked lakes of the area.

2. To determine the effect of rotenone treatment on food organisms utilized by games fishes of the area.

3. To determine limnological conditions which reflect the productivity of study lakes of the area.

4. To provide recommendations for the management of stocked lakes and to direct the course of future studies.

TECHNIQUES USED

Rainbow trout and choh salmon population size in study lakes was determined by Chapman's modification of the Peterson estimator (Ricker, 1975). Capture of fish for marking purposes was conducted with fyke nets. All captured trout or salmon were anesthetized, marked by hand, clipping the right or left pelvic fin and/or removal of the adipose fin, and transferred to a holding pen for a minimum of 24 hours. Marked fish were then enumerated and released. Mortalities were also noted at this time. After a two week period, fish were captured using 38.1 m X 1.8 m variable mesh monofilament gill nets composed of five different mesh panels ranging from 12.7 mm to 50.8 mm bar measure.

Catch rates and growth of fish in other study lakes were also determined by using the variable mesh monofilament gill nets. Nets were fished for a minimum of 24 hours. All fish measurements were expressed in fork lengths to the nearest millimeter and in weight to the nearest gram.

FINDINGS

A comprehensive overview of game fish stocking and gill net catch rates for study lakes is presented in Table 2. Catch rates of stocked Swanson and

Table 2. Lake Stocking and Gill Net Results in Selected Matanuska-Susitna Valley Lakes, 1967-1977.

Lake	MEI	Date Stocked	Specie*	Strain**	Size		Number of Fish Stocked	Density		Capture Date	Fish Per Gill Net Hour By Strain
					Fish/kg.	Fish/lb.		Fish/ha.	Fish/Acre		
Short Pine	2.1	7/26/73	RT	E	247	112	7,800	740	300		
		7/26/73	RT	W	275	125	7,800				
Christiansen	1.8	6/25/74	RT	E	388	176	13,500	876	354	5/30/75	0.17
		6/25/74	RT	W	2,293	1,040	50,000			5/30/75	0.15
		5/28/76	SS		752	341	26,900	374	150	10/25/77	2.60
Marion	0.4	6/25/74	RT	E	388	176	4,300	444	180	5/29/75	0.13
		6/25/74	RT	W	2,293	1,040	16,000			5/29/75	0.34
		10/ 4/76	RT	S	500	227	4,250	186	75	9/ 1/77	2.33
		10/ 4/76	RT	T	258	117	4,250			9/ 1/77	2.00
Johnson	7.4	9/ 4/69	RT	W	190	86	2,477	153	62		
		8/ 6/70	RT	W	767	348	7,318	452	183		
		6/14/71	RT	E	194	88					
		6/14/71	RT	E	212	96	11,997	741	300		
		6/14/71	RT	E	734	333					
		8/ 8/72	RT	E	73	33	8,000	494	200		
		----------				Post Treatment	----------				
		7/ 6/75	RT	E	456	207	11,997	741	300		
		7/ 2/76	RT	E	525	238	11,997	741	300		
Kepler	11.6	6/20/68	RT	W	3,693	1,675	6,000	329	133	5/ 7/69	1.23
		6/20/68	SS	BL	2,269	1,029				5/ 7/69	0.35
		8/ 2/68	RT	W	836	379	15,000	823	333		
		5/21/71	RT	E	254	115	28,200	1,548	627	11/18/71	0.08
		6/21/71	SS		1,045	474	5,000	274	111	11/18/71	1.09
		7/21/75	RT	E	304	138	8,700	955	385	9/16/76	0.02
		9/11/75	RT	S	855	388	8,700			9/16/76	1.65
Echo	15.9	6/20/68	RT	W	3,693	1,675	3,500	752	304	1/ 6/69	0.05
		6/20/68	SS		2,270	1,030	3,500			1/ 6/69	2.76
Victor	9.3	7/ 3/68	RT	W	2,169	984	3,000	1,072	400	12/18/68	0.19
		7/ 3/68	SS	BL	1,885	855	3,000			12/18/68	1.62
Reed	4.99	8/10/67	SS	BC	776	352	5,200	643	260	6/ 6/68	2.23
		6/10/69	G	TL			8,000	989	400	10/10/69	0.21
		9/14/70	RT	W	163	74	3,400	420	170	1/12/71	0.10
		5/25/71	RT	E	278	126	4,500	556	225	2/25/72	0.18
		9/ 6/72	RT	W	379	172	5,600	692	280	12/18/73	0.00
		----------				Post Treatment	----------				
		10/10/74	RT	S	291	132	1,500			10/ 2/75	1.23
		10/10/74	RT	T	216	98	2,578	874	354	10/ 2/75	1.48
		10/10/74	RT	T	216	98	3,000			10/ 2/75	2.53

Table 2. (Cont.) Lake Stocking and Gill Net Results in Selected Matanuska-Susitna Valley Lakes, 1967-1977.

Lake	MEI	Date Stocked	Specie*	Strain**	Size Fish/kg.	Size Fish/lb.	Number of Fish Stocked	Density Fish/ha.	Density Fish/Acre	Capture Date	Fish Per Gill Net Hour By Strain
Long***	9.4	6/20/75	RT	S	24	11	1,000	135	55	10/ 9/75	0.86
		6/20/75	RT	T	24	11	3,056			10/ 9/75	0.47
		10/ 5/76	RT	S	500	227	14,800	740	300	9/12/77	2.83
		10/ 5/76	RT	E	262	119	7,400			9/12/77	0.09
Big No Luck	1.1	10/ 1/75	RT	S	653	296	4,300	236	96	10/ 9/76	3.26
		10/ 1/75	RT	T	496	225	2,200			10/ 9/76	0.71
Canoe	18.1	10/ 1/75	RT	S	644	292	2,625	618	250	10/13/76	0.97
		10/ 1/75	RT	T	498	226	2,625			10/13/76	0.00
Marion	0.4	6/25/74	RT	E	388	176	4,300	444	180	5/29/75	0.34
		6/25/74	RT	W	2,299	1,043	16,000			5/29/75	0.13
		10/ 4/76	RT	S	500	227	4,250	186	76	9/ 1/77	2.33
		10/ 4/76	RT	T	258	117	4,250			9/ 1/77	2.00
Irene	10.4	8/ 2/68	RT	W	836	379	6,300	741	300	5/ 7/69	2.19
		8/ 6/69	RT	W	569	258	8,400	988	400	2/ 4/70	1.35
		9/14/70	RT	W	163	74	5,600	659	266	11/24/71	0.04
		5/28/71	RT	W	280	127	8,400	988	400	11/24/71	0.50
		9/ 8/72	RT	W	379	172	8,400	988	988	5/22/73	0.07
		7/26/73	RT	W	267	121	8,400	988	400	12/27/73	0.82
		7/30/75	RT	E	256	116	3,200	1,753	709	11/13/75	0.14
		7/30/75	RT	W	2,207	1,001	11,700			11/13/75	0.26
		10/ 5/76	RT	T	258	117	2,100			9/16/77	1.01
		10/ 5/76	RT	E	262	119	2,100	741	300	9/16/77	0.05
		10/ 5/76	RT	S	500	227	2,100			9/16/77	2.44
Ravine		8/ 6/70	RT	W	769	349	5,000	1,041	416	6/18/71	0.35
		6/10/71	RT	E	357	162	3,700	771	300	6/19/72	0.46
		9/ 8/72	RT	W	379	172	3,800	791	300	12/ 6/73	1.29
		6/29/73	RT	E	238	108	2,600	541	200	12/ 6/73	0.05
		7/ 8/75	RT	E	456	207	2,400	500	200	9/18/77	0.23
		10/ 5/76	RT	E	262	119	1,200	500	200	9/18/77	1.19
		10/ 5/76	RT	S	500	227	1,200				
Matanuska	8.2	8/ 9/72	RT	E	75	34	3,800	996	443	11/21/72	1.66
		9/ 5/72	RT	W	379	172	21,200			11/21/72	0.18
		6/29/73	RT	E	238	108	24,800	988	400	12/19/73	0.63
		6/25/74	RT	W	2,299	1,043	37,500	3,665	1,483	5/20/75	1.34
		6/25/74	RT	W	2,150	975	54,400			5/20/75	
		7/22/75	RT	E	304	138	9,300	741	300	5/27/76	0.72
		9/24/75	RT	E	130	59	9,300			5/27/76	
		10/ 4/76	RT	S	500	227	15,000	996	403	9/12/77	3.39
		10/ 4/76	RT	E	262	119	10,000			9/12/77	
Knik	9.9	10/ 5/76	RT	S	527	239	12,641	955	385	10/20/77	6.69
		5/16/77	RT	E	344	156	20,000	1,612	650	10/20/77	2.21

* Specie: RT = Rainbow trout, SS = Silver Salmon, G = Grayling.
** Origin of strain: E = Ennis, Montana; W = Winthrop, WN; S = Swanson River, AK; T = Talarik Creek, AK; BL = Bear Lake, AK; BC = Big Creek, Oregon, TL = Tolsona, AK.
*** Stickleback present.

Talarik trout, Salmo gairdneri Richardson, ranged from 0.97 to 6.69 fish per gill net hour, with an average of 3.6 trout per hour. In comparison, the catch of domestic trout ranged from 0.10 to 0.92 fish per hour. A comparison of catch rates in this manner may not be ideal because of differing environments, stocking densities, fish sizes and sampling dates; however, the overall results indicate that the stocked native Alaska trout have a greater survival than their domestic counterparts.

When wild Alaska fish were available for lake stocking the program was redesigned so wild and domestic trout could more directly be compared. The most notable changes in the program were: (1) equivalent handling of trout, (2) equal marking, i.e., left or right pelvic fin removal, (3) stocking wild and domestic fish in the same lake, and (4) sampling one year after stocking. Examination of net catch data (Table 3), actual and expected net catches, and percent superiority (Table 4) show a consistently higher survival of the Swanson strain. The apparent survival superiority of Swanson fish occurred despite the fact that the Swanson fingerlings were smaller than either the Talarik and/or Ennis fish at time of stocking.

Comparative growth assessment is complicated by differing lake fertilities, differing sizes of fish at stocking, and varying densities; however, in each of the varying lentic environments the Ennis fish were significantly larger at age I than the Alaska strains, (Table 5). Two lakes, Irene (MEI = 10.4) and Long (MEI = 9.4), were utilized in determining growth characteristics of the potential Alaska brood sources in competitor and competitor free environments. Irene was free of competitors at the time of stocking and Long Lake had stickleback present. Both lakes were stocked on the same date, with the same size fish at equivalent densities, and with the same ratio of wild to domestic fish. In each lake the introduced Ennis fingerlings were nearly twice as large as the Swanson fish (119/lb. vs. 227/lb/). One year later, when both lakes were netted, Swanson and Ennis trout lengths averaged 193 and 253 mm, respectively, in Irene Lake and 161 and 271 mm in Long Lake.

In the three lakes free of competitors where Talarik and Swanson fish were evaluated, Reed, Marion and Irene, the Talarik fish at age I averaged 201 mm and Swanson fish 175 mm. The Swanson fingerlings in each lake were substantially smaller than the Talarik fish at the time of stocking.

In Canoe Lake during the 1975-76 winter, oxygen measurements yielded a low of 0.8 ppm in February. The lake had been stocked during the previous October with both Swanson and Talarik fish. Netting a year later yielded only Swanson fish. Growth of the Swanson fish, length 304 mm, after one year was far superior to growth of fish in any of the other lakes.

In all study lakes, the age I Ennis trout had a higher average condition factor, 1.36, than either the Swanson or Talarik fish whose condition factors were 1.24 and 1.09, respectively.

Sampling and recapture techniques are still being developed; however, a case history of population estimates in Johnson Lake has yielded pertinent management information.

Table 3. Stocking and Gill Net Catch Data for Swanson, Talarik, and Ennis Rainbow Trout Strains in Selected Stocked Lakes of the Matanuska-Susitna Valleys, 1974-1977.

Lake	Strain*	Date Stocked	Number Stocked	Size		Density		Capture Date	Number Caught	Hrs. Fished Per Net	Nets Fished	Fish Per Gill Net Hr.	Total Fish/hr.
				Fish/kg.	Fish/lb.	Fish/ha.	Fish/Acre						
Reed	S	10/10/74	1,500	291	132			10/ 2/75	123	25	4	1.23	
	T	10/10/74	2,578	216	98	874	354	10/ 2/75	145	24.5	4	1.48	5.24
	T	10/10/74	3,000	216	98			10/ 2/75	255	25	4	2.53	
Long	S	6/20/75	1,000	24	11	135	55	10/ 9/75	83	24	4	0.86	1.34
	T	6/20/75	3,056	24	11			10/ 9/75	46	24.5	4	0.47	
	S	10/ 5/76	14,800	500	227	740	300	9/12/77	333	23.5	5	2.83	2.92
	E	10/ 5/76	7,400	262	119			9/12/77	11	23.5	5	0.09	
Big No Luck	S	10/ 1/75	4,300	653	296	236	96	10/ 9/76	250	25.5	3	3.26	3.98
	T	10/ 1/75	2,200	496	225			10/ 9/76	55	25.5	3	0.72	
Canoe	S	10/ 1/75	2,625	644	292	618	250	10/13/76	70	24	3	0.97	0.97
	T	10/ 1/75	2,625	498	226			10/13/76	0	24	3	0	
Irene	S	10/ 5/76	2,100	500	227			9/16/77	176	24	3	2.44	
	T	10/ 5/76	2,100	258	117	741	300	9/16/77	73	24	3	1.01	3.51
	E	10/ 5/76	2,100	262	119			9/16/77	4	24	3	0.06	
Marion	S	10/ 4/76	4,250	500	227	186	76	9/ 1/77	56	24	1	2.33	4.33
	T	10/ 4/76	4,250	258	117			9/ 1/77	48	24	1	2.00	
Kepler	S	9/11/75	8,700	855	388	955	385	9/16/76	129	26	3	1.65	1.68
	E	7/21/75	8,700	304	138			9/16/76	2	26	3	0.03	
Ravine	S	10/ 5/76	1,200	500	227	500	200	9/18/77	115	24	4	1.20	1.44
	E	10/ 5/76	1,200	262	119			9/18/77	23	24	4	0.24	
Matanuska	S	10/ 4/76	15,000	500	227	996	403	9/12/77	309	22.75	4	3.40	3.49
	E	10/ 4/76	10,000	262	119			9/12/77	8	22.75	4	0.09	
Knik	S	10/ 5/76	12,641	527	239	955	385	10/20/77	442	22	3	6.70	8.91
	E	5/16/77	20,000	344	156	1,612	650	10/20/77	146	22	3	2.21	

* S - Swanson
T - Talarik
E - Ennis

Table 4. Comparative Survivals and Percent Superiority for Rainbow Trout, 1974-1977.

Lake	Strain*	Number Stocked	Observed Captured	Expected Capture	Observed Estimated Non-Captured	Expected Estimated Non-Captured	Chi Square Totals	Tabled Chi (p=0.01) Square	Percent Superiority
Reed	S	1,500	123	111	1,377	1,266	25	1 d.f.	43
	T	2,578	148	191	2,430	2,239		2.71	
Long	S	1,000	83	32	917	3,010	112	1 d.f.	451
	T	3,056	46	97	885	2,913		2.71	
	S	14,800	333	11	14,467	7,389	145	1 d.f.	1,414
	E	7,400	229	115	14,238	7,374		2.71	
Big No Luck	S	4,300	250	201	4,051	3,850	49	1 d.f.	132
	T	2,200	55	103	2,145	2,042		2.71	
Canoe	S	2,625	70	35	2,555	2,520			
	T	2,625	0	35	2,625	2,590			
Irene	S	2,100	176	84	1,924	1,840		2 d.f.	
	T	2,100	73	84	2,027	1,943	189		141
	E	2,100	4	84	2,096	2,012		4.61	4,300
Marion	S	4,250	187	172	4,063	3,891	18	1 d.f.	19
	T	4,250	157	172	4,093	3,921		2.71	
Kepler	S	8,700	129	64	8,571	8,507	127	1 d.f.	6,350
	E	8,700	2	64	8,698	8,634		2.71	
Ravine	S	1,200	115	69	1,085	1,016	70	1 d.f.	400
	T	1,200	23	69	1,177	1,108		2.71	
Matanuska	S	15,000	309	190	14,691	14,501	190	1 d.f.	2,475
	E	10,000	8	127	9,992	9,865		2.71	
Knik	S	12,641	442	223	12,388	12,155	358	1 d.f.	379
	E	20,000	146	360	19,854	19,489		2.71	

* S - Swanson
T - Talarik
E - Ennis

Table 5. Length-Weight Summaries for Rainbow Trout in Selected Matanuska-Susitna Valley Lakes, 1974-1977.

Lake	Strain*	Date Stocked	Number Stocked	Capture Date	Number Captured	Mean L (mm)	SD_L	Mean W (g)	SD_W	Condition Factor
Reed	S	10/10/74	1,500	10/ 2/75	123	180	16	61	19	1.04
	T	10/10/74	2,578	10/ 2/75	148	183	16	65	19	1.06
	T	10/10/74	3,000	10/ 2/75	253	182	20	65	20	1.07
	S	10/10/74	1,500	6/29/76	20	233	13	141	24	1.11
	T	10/10/74	2,578	6/29/76	21	225	26	137	46	1.20
	T	10/10/74	3,000	6/29/76	43	224	21	133	39	1.18
	S	10/10/74	1,500	9/21/76	22	295	18	288	51	1.12
	T	10/10/74	2,578	9/21/76	7	293	23	288	69	1.14
	T	10/10/74	3,000	9/21/76	26	293	25	311	66	1.23
	S	10/10/74	1,500	10/12/77	2	400		656		1.02
	T	10/10/74	2,578	10/12/77	2	424		857		1.12
	T	10/10/74	3,000	10/12/77	0					
Long	S	6/20/75	1,000	10/ 9/75	83	247	32	180	75	1.19
	T	6/20/75	3,056	10/ 9/75	46	245	27	166	54	1.12
	S	6/20/75	1,000	7/ 6/76	10	352	48	546	283	1.25
	T	6/20/75	3,056	7/ 6/76	14	345	53	496	234	1.20
	S	10/ 5/76	14,800	9/12/77	333	161	32	62	35	1.48
	E	10/ 5/76	7,400	9/12/77	11	271	36	312	120	1.56
Big No Luck	S	10/ 1/75	4,300	10/ 9/76	250	177	14	60	17	1.08
	T	10/ 1/75	2,200	10/ 9/76	55	193	26	79	28	1.09
Canoe	S	10/ 1/75	2,625	10/13/76	70	304	23	421	115	1.49
	T	10/ 1/75	2,625	10/13/76	0					
	S	10/ 1/75	2,625	10/24/77	5	520		1,956		1.39
	T	10/ 1/75	2,625	10/24/77	0					
Irene	S	10/ 5/76	2,100	9/16/77	176	193	20	82	35	1.14
	T	10/ 5/76	2,100	9/16/77	73	231	30	136	50	1.10
	E	10/ 5/76	2,100	9/16/77	4	253	19	206	31	1.27
Marion	S	10/ 4/76	4,250	9/ 1/77	56	153	24	39	23	1.08
	T	10/ 4/76	4,250	9/ 1/77	48	190	32	72	34	1.04
Kepler	S	9/11/75	8,700	9/16/76	129	172	21	63	29	1.23
	E	7/21/75	8,700	9/16/76	2	319		380		1.17
Ravine	S	10/ 5/76	1,200	9/ 8/77	115	208	23	113	39	1.25
	E	10/ 5/76	1,200	9/ 8/77	23	230	29	169	79	1.38
Matanuska	S	10/ 4/76	15,000	9/12/77	309	179	23	72	30	1.25
	E	10/ 4/76	10,000	9/12/77	8	252	20	230	68	1.43
Knik	S	10/ 5/76	12,641	10/20/77	130	156	31	53	24	1.39
	E	5/16/77	20,000	10/20/77	43	196	14	111	22	1.47

* S - Swanson
T - Talarik
E - Ennis

Definitive trout investigations in Johnson Lake have been ongoing since 1969. Prior to September, 1973, Johnson Lake was inhabitated by stickleback, Gasterosteus aculeatus Linnaeus, and stocked annually with domestic rainbow trout of either the Ennis or Winthrop strain. The initial intent was to determine survival and growth of rainbow trout fingerlings under varying stocking conditions when in competition with indigenous threespine stickleback.

A total of 2,496 fingerling trout, weighing 187/kg (85 per pound) were stocked in Johnson Lake on September 4, 1969 at a density of 153 fish per surface hectare (62 fish per surface acre). No older game fish were present. Survival of this plant was evaluated by Redick (1971) in the Spring of 1970. Redick reported a survival of 24.3%. In 1971, additional data were collected on the survival of the 1969 planting after which Redick (1972) concluded that the final survival estimate of the 1969 planting approximated 25%.

The second planting was designed to duplicate stocking procedures in terms of planting density and fingerlings size in use for managed lakes of the Matanuska and Susitna Valleys. In August, 1970, Johnson Lake was stocked with 7,446 rainbow trout, weighing 769/kg (349 per pound), at a density of 452 fish per hectare (183 fish per surface acre). A few age I trout from the 1969 plant and an indigenous population of threespine stickleback were already present in the lake. A total of 322 hours of gill netting was conducted the following spring during May and June. Not a single individual from the 1970 plant was recovered.

In June, 1971 Johnson Lake was planted with 12,018 rainbow trout fingerling. This plant consisted of three different sizes of rainbow trout which were stocked at a total combined density of 741 fish per surface hectare (300 fish per surface acre). Various numbers and sizes of trout stocked are as follows: 4,419 fish at 194/kg (88/pound) LV fin clip, 3,628 fish at 211/kg (96/pound) RV fin clip, and 3,971 fish at 734/kg (333/pound), no clip. It was expected that rainbow trout weighing 194 and 211/kg would have greater survival than the 734/kg fish; however, a subsequent population estimate indicated the reverse. Marked fish initially weighing 194, 211, and 734/kg had respective survival estimates of 3%, 3.5% and 4.1%. Again, no measurable survival was indicated for fall, 1970 planted trout.

Examination of all population data, 1970-1972, indicated greater survival for larger fish when they were stocked at lower densities, Table 6. Based on this, it was decided to make a final rainbow trout plant using the largest size fingerling available and stocking at a medium density. This plant was made in August, 1972, comprising 7,875 fingerling trout at 75/kg (34/pound) at a density of 494/hectare (200/acre). The subsequent population estimate in spring, 1973, using Bailey's modification of the Peterson estimator at the 95% confidence interval resulted in an estimate of 1,770 trout, or a 22% survival of the August, 1972 plant.

The 1972 rainbow plant marked the completion of the first phase of study in stickleback waters. A complete kill of sticklebacks was obtained after fall rotenoning in 1973. Johnson Lake had detoxified during the

Table 6. Summary of Rainbow Trout Stocking Histories, Population Estimates and Biomass in Matanuska Valley Study Lakes, 1969-1974.

Lake	Stocking History						Estimates After One Year		Biomass* Lbs.	
	Stocked	Number	Per kg.	Per lb.	Per Ha.	Per Acre	Population Size	% Survival	/ha.	/sfc. Acre
Johnson	1969	2,496	187	85	153	62	606	24.3	1.5	0.6
	1970	7,446	769	349	452	183	NO FISH RECOVERED			
	1971**	4,419	194	88			126	2.9		
		3,628	211	96	741	300	128	3.5	6.2	2.5
		3,971	734	333			161	4.1		
	1972	7,875	75	34	494	200	1,770	22.5	18.5	7.5
	1975***	12,000	456	207	741	300	1,639	13.7	56.8	23.5
	1976	12,000	525	238	741	300	1,801	15.0	49.6	20.8
Short Pine	1973	15,600	262	119	741	300	2,110	13.5	17.0	6.9
Marion	1974	20,300	2,105	955	185	75	1,649	8.1	7.2	2.9
Christianson	1974	63,500	2,105	955	371	150	1,778	2.8	2.7	1.1

* Based on population estimate of survival for that year's stocking.
** Total number of fish stocked was 12,018 at a combined density equal to 300 fish per surface acre.
*** Stocking duplicates 1971.

following winter but lay fallow the entire summer of 1974. The first post-chemical treatment stocking of rainbow trout occurred in July of 1975 with a plant of 12,000/207 lb., or 300 fish per surface acre. This stocking was intended to duplicate stocking densities in other lakes of the Matanuska-Susitna Valleys, and to achieve comparable or higher survival than prior stockings. At the 95% confidence interval the population size in spring, 1976 of the July 1975 rainbow trout plant was an estimated 1,639 fish, or 13% of the original plant.

In another effort to duplicate results, Johnson Lake was stocked with 12,000/238 lb. or 300 fish per surface acre. This stocking was similar to the previous year's and to that of other study lakes. In an effort to duplicate an intense spring sport fishery, gill nets were used after Johnson Lake was ice free. Netting resulted in a catch of 873 fish. Three hundred hatchery trout were selected which were equivalent in size to the netted fish. The 300 were marked and placed in Johnson Lake. After an acclimation period of two weeks a population estimate at the 95% confidence interval of the July 1976 plant was an estimated 1,801, including the 873 gill netted fish. This represents 15% of the original plant. The estimate is quite similar to the 13% or 1,639 fish survival of the 1975 plant.

Fish population studies were also conducted to assess stocking of land-locked coho, Oncorhynchus kisutch (Walbaum). Only two coho population estimates have been made in Matanuska-Susitna Valley lakes; however, simultaneous plants of coho and rainbow trout have been made for comparison purposes.

Christiansen Lake has received plants of both rainbow trout and coho. For rainbow trout, one year after stocking, the population estimate was determined to be only 7% of the original plant, while that for coho was 40% of the original plant. In other lentic environments, gill netting results indicate that coho exhibit better survival. For instance, Echo Lake was planted with equal numbers of 1,884/kg (855/lb.) coho and 2,169/kg (984/lb.) rainbows in July, 1968. Gill netting six months after introduction yielded a catch of 76 coho and nine rainbows. Although a higher survival is indicated for coho, their growth is inferior compared to domestic trout, as shown in growth curves compiled by Watsjold (1976), Figure 1.

In other landlocked coho salmon survival studies Peckham (1974, 1975) also noted higher survivals of coho (Table 7). Coho studies thus far show survivals ranging from 24% to 90%, with an approximate mean of 55% compared to survivals of domestic trout of 0 to 24%, with a mean survival of 7% to 10%. Salmon survival is substantially greater.

Production cost for salmon and trout at Fire Lake Hatchery (Joe Wallis, unpublished data, 1972-1973) is presented in Table 8. These costs do not include egg takes because of the inconsistent dollar value of such operations, but represent the cost involved in wages, feeding, etc., from the moment fish eggs are placed in the hatchery through stocking. For example, using data from Johnson Lake, 1972-1973, the estimated value per

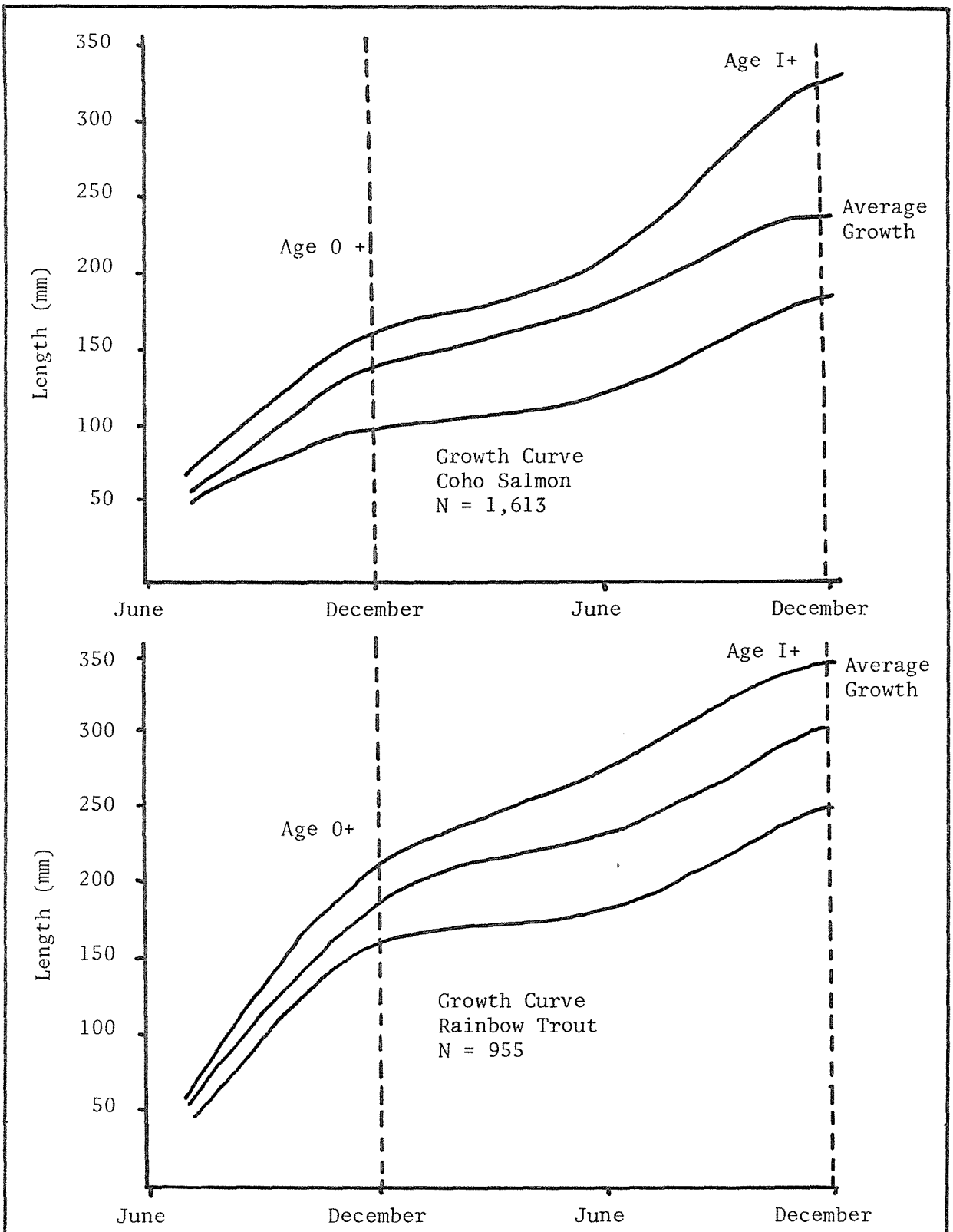

Figure 1. Growth Curves of Coho Salmon and Rainbow Trout Showing High, Low and Average Growth in Stocked Matanuska-Susitna Valley Lakes Below 500 Feet Elevation, 1975-1976.

Table 7. Coho Salmon Survival in Study Lakes, 1977.

Date	Date Stocked	Size		Percent Survival To One Year
		Fish/kg.	Fish/lb.	
Lisa	8/29/72	536	243	55
Jim	9/29/72	536	243	24
Bolio	7/13/73	970	440	88-97
Little Harding	8/ /76	168	76	82
Loon	8/ 8/73	315	143	40-50
Christiansen	5/28/76	752	341	40*

* Domestic rainbow fingerlings at 176/lb. yielded a 7% first year survival in 1975.

Table 8. Production Cost for Salmon and Trout at Fire Lake Hatchery, 1972-1973.

Average Size		Estimated Cost in Dollars	Cost of Fish in Dollars	
Fish/lb.	Fish/kg.	Per 100,000 Fish	Per lb.	Per kg.
1,000	2,200	2,000	20.00	44.09
300	660	2,000	6.50	14.33
250	550	2,200	5.50	12.13
150	330	3,200	4.80	10.58
100	220	4,600	4.60	10.14
50	110	9,000	4.50	9.92
Smolt	9-20			

fish at an average size of 75/kg (34/pound) was $0.12. The transportation cost for the total planting was approximately $50. Thus the total expense of planting 7,875 fingerling was $975.

The harvest rate for age I fish would vary depending upon fish survival and fishing intensity, so the estimated value to the creel per fish was calculated for 100%, 75%, and 50% harvest levels. Costs are presented for Matanuska-Susitna Valley lakes for which survival and biomass data are available (Tables 9 and 10). It is apparent that when similar age I population levels are reached in Johnson Lake (which had stickleback in 1972, but was free of them in 1975 and 1976) the cost to the creel and cost of raising a catchable fish in a stickleback environment is more than two times as great. the cost per pound of fish is nine times greater in a stickleback environment than in a non-stickleback environment.

Lakes, including Short Pine, Marion, and Christiansen, also have biomass and population estimates and are characterized by lower productivity levels, while Johnson Lake is considered a moderately productive lake. Population estimates and biomass determinations for rainbow trout in Marion and Christiansen lakes are also presented in Table 9. Based on the estimated cost to the creel and on the survival of trout in low production lakes, it is apparent that survival of fry and small fingerling will be consistently lower than 15% of the original plant and that cost of producing a catchable fish will be quite high, i.e., $0.40 to $2.00 at a 50% harvest level. These costs would be substantially less in lakes stocked with coho, especially when survivals upward of 40% have been attained in various lakes. However, in a creel census conducted by Watsjold (1977) anglers were asked to list in order of preference what fish species they would like to fish for in Cook Inlet Basin stocked lakes--rainbow, landlocked coho, or grayling. Of the 500 plus individuals responding, 70% listed rainbow as their first choice, 19% favored coho, and the balance preferred grayling. Based on this, development of acceptable survivals of rainbow trout in study lakes is of prime importance.

DISCUSSION

Two strains of Alaska rainbow trout, Swanson River trout and Talarik Creek trout, from widely differing environments were reared under hatchery conditions with the domesticated Ennis rainbows. Survival and growth of native and domestic fish in various lentic environments have been compared after their first year of life. These studies were also related to the performance of landlocked silver salmon.

Chi-square and percent superiority based on gill netting results indicate the Alaska trout strains have a better first year survival than the domestic strain. In a comparison of the two Alaska strains, the Swanson fish consistently had better first year survival; however, the growth of Talarik fish was somewhat greater. the growth rates of Alaska fish were less than the domestic Ennis fish.

Table 9. Estimated Stocking Cost of Stocked Fish in Study Lakes, 1969-1976.

Lake	Year	Species*	Population Size	Percent Survival	Biomass (lbs/acre)	Stocking Cost** Total	Stocking Cost** Per Fish
Johnson	1969	RT	606	24.3	0.6	170	0.07
	1970	RT		NO FISH RECOVERED		175	0.02
	1971	RT	415	3.5	2.5	258	0.02
	1972	RT	1,770	22.0	4.5	975	0.12
	1975***	RT	1,639	13.6	23.5	348	0.03
	1976	RT	1,801	15.0	20.8	348	0.03
Short Pine	1973	RT	2,110	13.5	6.7	372	0.02
Marion	1974	RT	1,649	8.0	2.9	678	0.02
Christiansen	1974	RT	1,778	2.8	1.1	1,207	0.02
	1976	SS	10,821	40.0	8.2	1,677	0.06

* RT - Rainbow Trout, SS - silver salmon.

** Based on initial stocking history, i.e., number of fish stocked, number per pound, total pounds stocked, number total pounds stocked per surface acre, and transportation costs.

*** Chemical rehabilitation prior to this plant.

Table 10. Estimated Cost to the Creel of Stocked Fish in Study Lakes, 1969-1976.

Lake	Sticklebacks Present	Year	Species*	Cost to the Creel by Percent Harvest					
				100%		75%		50%	
				Per Fish	Per Lb. Fish	Per Fish	Per Lb. Fish	Per Fish	Per Lb. Fish
Johnson	X	1969	RT	0.28	7.00	0.42	10.50	0.56	14.00
	X	1970	RT		NO FISH RECOVERED				
	X	1971	RT	0.62	2.58	0.93	3.87	1.24	5.16
	X	1972	RT	0.50	3.23	0.75	4.85	1.00	6.46
		1975**	RT	0.21	0.37	0.32	0.55	0.42	0.74
		1976	RT	0.19	0.42	0.29	0.63	0.38	0.84
Short Pine		1973	RT	0.18	1.04	0.27	1.56	0.36	2.08
Marion		1974	RT	0.41	2.05	0.62	3.08	0.82	4.10
Christiansen		1974	RT	0.68	3.09	1.02	4.64	1.36	6.18
		1976	SS	0.15	0.83	0.23	1.25	0.30	1.66

* RT - Rainbow trout, SS - silver salmon.
** 1975 was the first year of stocking in Johnson Lake after rehabilitation.

Rainbow trout fingerling survival in Canoe and Long lakes indicates the Swanson strain may have greater tolerance to low dissolved oxygen and to stickleback competition.

In other rainbow trout studies utilizing Ennis fish the data indicate that the numerical survival of fish is increased when competitor species such as threespine stickleback are eradicated and when larger fish are stocked at lower densities. The highest survival of domestic fingerling during the 1969-1976 period was 25% of the original plant, with an average survival of 7% to 10%. Poorer survivals were noted in waters of low fertility and where competitor species were present. Landlocked coho in lakes where population estimates have been made show a high survival to age I. Survivals lie in the range of 40% to 97%; however, growth when plotted on growth curves and compared to trout is inferior.

Closely related to these studies is the cost-benefit or cost of producing a catchable fish. When similar age I population levels were achieved in a stickleback and non-stickleback environment, the cost of a fish to the creel in a stickleback environment was twice as great and the cost per pound of fish nine times greater. These data also indicate that domestic fry and fingerling survivals are consistently less than 15% of the original plant, consequently at a 50% harvest level the production of a catchable fish will be quite high, i.e., $0.40 to $2.00. This cost would be substantially lower in lakes stocked with landlocked coho; however, in a Cook Inlet Basin creel census of stocked landlocked lakes, angler preference was for rainbow trout.

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